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BIBLIOTHÈQUE DE L'ÉCOLE POLYTECHNIQUE DE MONTRÉAL

# $\nu$ GEMINORUM, A LONG PERIOD BINARY

BY W. E. HARPER, M.A.

(1900, $\alpha = 6^h\ 23^m.0$, $\delta = +\ 20^\circ\ 17'$, mag. 4.06, type B5)

This star was announced as a spectroscopic binary by Lee in the *Astrophysical Journal*, volume XXXII, page 301, from 5 plates taken in the years 1901 to 1909 which showed a range of 27 km., and whose measures are given in the accompanying table. It was noted that the $H$ and $K$ lines of calcium gave velocities different to the other lines.

A series of plates were made here during the years 1910, 1911, 1912, 1913 and 1914, 52 of these plates were measured by Mr. T. H. Parker without giving any clue to the period. When Mr. Parker responded to a higher call and went overseas, the star was taken over by the writer and plates have been made from time to time, so that now we have 83 altogether. While Mr. Parker's measures were felt to be just as reliable as any that could be made upon the plates, yet, owing to the complex character of the lines and the possibility of different interpretations being placed upon them, it was thought better for the writer to measure all the plates and thereby possibly secure greater homogeneity.

While the helium lines $\lambda$ 4471 and $\lambda$ 4026 can be detected on most of our plates, they are, with possibly the exception of one plate, entirely too faint to be measured and consequently the results depend upon the four hydrogen lines $H_\beta$, $H_\gamma$, $H_\delta$, and $H_\epsilon$. $H_\epsilon$ is only rarely used, $H_\gamma$ is by far the most dependable line with $H_\delta$ next in order and then $H_\beta$. The numbers 9, 4 and 3 would express the relative weights of these three. The measures of the calcium line $K$ have been kept separate as Lee's discovery of its distinct character has been verified, even though the line lacks contrast and is of extremely poor quality for measurement. While the extreme variation shown for measures of this line is in the neighbourhood of 50 km., yet this range is only shown where the line is very poor and the measurement uncertain and it is not likely that the real range is much over half this amount. There does not seem to be any progressive variation over a long period, as is the case for the hydrogen lines; the velocities for each year average up about the same. The weighted mean velocity for the line on 33 plates is + 16.9 km. per second, while that of the center of the system is in the neighbourhood of + 38 km. per second.

That there is a short-period oscillation in the velocities would seem to be without doubt, but a satisfactory period has not as yet been obtained. As the range in velocity

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of this short-period variation is small, it has been possible by combining the velocities for each season into one mean to detect a long-period variation. There are, unfortunately, a few gaps yet to be filled in, but there seems no doubt of the general trend of the velocities over a curve whose period is about 9·6 years. The Yerkes' plates and our own are used in the table of measures and in the grouped velocities following. To clear of fractions the weights assigned to plates are 8 times the total weight of the lines on the plates.

OBSERVATIONS OF $\nu$ GEMINORUM

| Plate | Date | Julian Date | Vel. *H* lines | Wt. | Vel. Calcium | Wt. |
|---|---|---|---|---|---|---|
| | 1903 | | | | | |
| Yerkes | Dec. 1 | 2,416,450·953 | +24·0 | ..... | − 6 | ..... |
| " | " 25 | 6,474·945 | 33·0 | ..... | + 1 | ..... |
| | 1906 | | | | | |
| " | Feb. 26 | 7,268·742 | 6·0 | ..... | +22 | ..... |
| | 1908 | | | | | |
| " | Jan. 24 | 7,965·727 | 15·0 | ..... | +12 | ..... |
| | 1909 | | | | | |
| " | Jan. 1 | 8,308·777 | 20·0 | ..... | ..... | ..... |
| | 1910 | | | | | |
| 3743 | Oct. 12 | 8,957·932 | 97·6 | 5 | − 4 | 1 |
| 3795 | Nov. 2 | 8,978·910 | 59·6 | 8 | ..... | ..... |
| 3824 | Dec. 5 | 9,011·944 | 62·9 | 6 | +28 | 1 |
| 3848 | " 9 | 9,015·874 | 78·8 | 7 | +28 | 1 |
| 3882 | " 16 | 9,022·816 | 75·7 | 4 | +39 | 1 |
| 3892 | " 21 | 9,027·834 | 81·6 | 8 | +16 | 2 |
| 3910 | " 30 | 9,036·827 | 48·4 | 4 | ..... | ..... |
| | 1911 | | | | | |
| 3924 | Jan. 9 | 9,046·715 | 52·0 | 6 | ..... | ..... |
| 3941 | " 16 | 9,053·852 | 40·9 | 6 | + 4 | 2 |
| 3950 | " 17 | 9,054·832 | 49·2 | 4 | +21 | 1 |
| 3975 | " 30 | 9,067·705 | 94·3 | 12 | + 8 | 1 |
| 3997 | Feb. 15 | 9,083·730 | 73·2 | 6 | ..... | ..... |
| 4008 | " 22 | 9,090·714 | 58·4 | 4 | + 7 | 1 |
| 4021 | " 27 | 9,095·625 | 61·1 | 7 | + 4 | 1 |
| 4059 | Mar. 6 | 9,102·670 | 42·3 | 4 | ..... | ..... |
| 4069 | " 7 | 9,103·628 | 63·7 | 10 | ..... | ..... |
| 4088 | " 10 | 9,106·593 | 74·3 | 9 | +19 | 4 |
| 4101 | " 13 | 9,109·612 | 71·4 | 6 | ..... | ..... |
| 4115 | " 14 | 9,110·614 | 70·4 | 10 | +27 | 4 |
| 4119 | " 16 | 9,112·614 | 72·9 | 6 | +31 | 1 |
| 4133 | " 20 | 9,116·583 | 73·6 | 13 | ..... | ..... |
| 4136 | " 24 | 9,120·593 | 76·2 | 16 | + 8 | 4 |
| 4638 | Oct. 12 | 9,322·924 | 66·5 | 10 | +34 | 1 |
| 4698 | Nov. 16 | 9,357·911 | 55·9 | 8 | +24 | 4 |
| 4710 | Dec. 3 | 9,374·903 | 72·3 | 7 | ..... | ..... |
| 4719 | " 6 | 9,377·850 | 60·8 | 10 | ..... | ..... |
| 4732 | " 19 | 9,390·718 | 63·4 | 10 | +18 | 2 |
| 4740 | " 25 | 9,396·784 | 74·5 | 12 | ..... | ..... |
| | 1912 | | | | | |
| 4752 | Jan. 7 | 9,409·763 | 68·2 | 7 | ..... | ..... |
| 4763 | " 10 | 9,412·753 | 57·8 | 9 | ..... | ..... |
| 4782 | " 12 | 9,414·776 | 69·3 | 12 | + 5 | 1 |
| 4794 | " 16 | 9,418·729 | 63·8 | 10 | ..... | ..... |
| 4803 | " 19 | 9,421·740 | +72·8 | 16 | +31 | 1 |

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OBSERVATIONS OF ν GEMINORUM—*Concluded*

| Plate | Date | Julian Date | Vel. *H* lines | Wt. | Vel. Calcium | Wt. |
|---|---|---|---|---|---|---|
| | 1912 | | | | | |
| 4813 | Jan. 25 | 2,419,427·763 | +52·6 | 10 | +36 | 1 |
| 4821 | " 26 | 9,428·734 | 25·5 | 8 | +11 | 1 |
| 4836 | Feb. 12 | 9,445·690 | 72·9 | 10 | ..... | ..... |
| 4841 | " 13 | 9,446·635 | 61·4 | 12 | ..... | ..... |
| 4872 | Mar. 5 | 9,467·716 | 64·2 | 12 | +13 | 2 |
| 4883 | " 12 | 9,474·697 | 65·5 | 6 | ..... | ..... |
| 4886 | " 13 | 9,475·635 | 56·9 | 6 | + 2 | 1 |
| 4903 | " 20 | 9,482·600 | 63·0 | 8 | ..... | ..... |
| 4907 | " 22 | 9,484·600 | 76·2 | 10 | ..... | ..... |
| 4915 | " 25 | 9,487·604 | 64·8 | 9 | +24 | 1 |
| 4924 | " 29 | 9,491·645 | 50·7 | 7 | +20 | 1 |
| 4933 | Apr. 3 | 9,496·581 | 62·7 | 16 | ..... | ..... |
| 4940 | " 8 | 9,501·524 | 75·3 | 16 | ..... | ..... |
| 4965 | " 19 | 9,512·538 | 58·8 | 9 | −10 | 1 |
| 4976 | " 23 | 9,516·543 | 58·1 | 8 | ..... | ..... |
| 5285 | Dec. 16 | 9,753·871 | 58·2 | 8 | ..... | ..... |
| | 1913 | | | | | |
| 5311 | Jan. 8 | 9,776·830 | 58·3 | 10 | − 3 | 4 |
| 5315 | " 12 | 9,780·771 | 65·6 | 12 | +25 | 4 |
| 5339 | Feb. 3 | 9,802·750 | 56·2 | 10 | +46 | 1 |
| 5350 | " 6 | 9,805·708 | 43·1 | 6 | ..... | ..... |
| 5356 | " 10 | 9,809·687 | 44·2 | 8 | + 6 | 2 |
| 5362 | " 12 | 9,811·690 | 57·1 | 8 | ..... | ..... |
| 5372 | " 17 | 9,816·658 | 53·1 | 10 | ..... | ..... |
| 5387 | " 23 | 9,822·632 | 53·6 | 14 | +16 | 2 |
| 5394 | " 24 | 9,823·697 | 58·7 | 14 | ..... | ..... |
| 5409 | " 28 | 9,827·641 | 63·5 | 10 | ..... | ..... |
| 5418 | Mar. 7 | 9,834·680 | 60·0 | 8 | ..... | ..... |
| 5429 | " 11 | 9,838·674 | 60·5 | 8 | ..... | ..... |
| 5447 | Apr. 7 | 9,865·590 | 38·9 | 8 | ..... | ..... |
| 5456 | " 9 | 9,867·589 | 54·5 | 10 | ..... | ..... |
| 5469 | " 14 | 9,872·607 | 56·8 | 6 | ..... | ..... |
| 5496 | " 21 | 9,879·593 | 53·5 | 10 | ..... | ..... |
| 5851 | Dec. 22 | 2,420,124·836 | 31·3 | 8 | ..... | ..... |
| 5866 | " 31 | 0,133·751 | 47·8 | 5 | ..... | ..... |
| | 1914 | | | | | |
| 5895 | Jan. 21 | 0,154·727 | 47·1 | 10 | ..... | ..... |
| 5923 | Feb. 9 | 0,173·740 | 37·8 | 3 | ..... | ..... |
| 5940 | " 15 | 0,179·633 | 36·9 | 10 | + 9 | 2 |
| | 1916 | | | | | |
| 7482 | Jan. 13 | 9,876·620 | 3·2 | 10 | ..... | ..... |
| 7519 | Feb. 23 | 0,917·653 | 13·0 | 6 | ..... | ..... |
| 7528 | " 29 | 0,923·664 | 4·4 | 4 | ..... | ..... |
| 7533 | Mar. 1 | 0,924·548 | 26·7 | 6 | ..... | ..... |
| 7606 | Apr. 10 | 0,964·549 | 26·2 | 6 | ..... | ..... |
| 7622 | " 27 | 0,981·561 | 19·4 | 7 | ..... | ..... |
| | 1919 | | | | | |
| 8701 | Jan. 21 | 1,980·676 | 37·8 | 10 | − 2 | 1 |
| 8702 | " 24 | 1,983·676 | 48·2 | 8 | ..... | ..... |
| 8708 | " 31 | 1,990·616 | 37·4 | 10 | ..... | ..... |
| 8710 | Feb. 10 | 2,000·571 | 33·0 | 12 | ..... | ..... |
| 8712 | " 12 | 2,002·583 | 33·2 | 14 | ..... | ..... |
| 8713 | " 16 | 2,006·647 | 30·5 | 8 | ..... | ..... |
| 8714 | " 16 | 2,422,006·695 | +33·6 | 10 | ..... | ..... |

MEASURES OF $\nu$ GEMINORUM

| λ | 3743 | | 3795 | | 3824 | | 3848 | | 3882 | | 3892 | | 3910 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +74·5 | 1/8 | +42·8 | 1/4 | +82·3 | 1/8 | +102·6 | 1/8 | +65·6 | 1/8 | +73·2 | 1/8 | +55·6 | 1/8 |
| 4340 | 81·4 | 1/4 | 47·2 | 1/2 | 42·9 | 1/2 | 53·5 | 1/2 | 79·0 | 1/4 | 83·6 | 3/4 | 41·4 | 1/4 |
| 4101 | +54·1 | 1/4 | +35·0 | 1/4 | +59·8 | 1/8 | + 86·8 | 1/4 | +58·6 | 1/8 | +57·9 | 1/8 | +63·4 | 1/4 |
| Weighted mean | + 69·10 | | + 43·05 | | + 52·28 | | + 70·03 | | + 70·55 | | + 79·09 | | + 50·45 | |
| $V_a$ | + 28·83 | | + 16·81 | | + 11·13 | | + 9·19 | | + 5·64 | | + 3·02 | | − 1·58 | |
| $V_d$ | − ·04 | | ·00 | | − ·27 | | − ·18 | | − ·18 | | − ·18 | | − ·21 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | + 97·6 | | + 59·6 | | + 62·9 | | + 78·8 | | + 75·7 | | + 81·6 | | + 48·4 | |

| λ | 3924 | | 3941 | | 3950 | | 3975 | | 3997 | | 4008 | | 4021 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +68·4 | 1/8 | +72·6 | 1/8 | +84·1 | 1/8 | +98·6 | 1/4 | +101·0 | 1/8 | +97·8 | 1/8 | +85·3 | 1/4 |
| 4340 | 55·9 | 1/2 | 42·4 | 1/2 | 46·8 | 1/4 | 122·7 | 3/4 | 94·9 | 1/2 | 89·3 | 1/4 | 91·6 | 1/2 |
| 4101 | +63·8 | 1/8 | +69·4 | 1/8 | +61·3 | 1/8 | +101·7 | 1/2 | +100·0 | 1/8 | +60·0 | 1/8 | +79·7 | 1/8 |
| Weighted mean | +59·30 | | +51·93 | | +59·75 | | +111·68 | | +96·77 | | +84·10 | | +88·10 | |
| $V_a$ | − 6·90 | | −10·50 | | −10·04 | | − 16·95 | | −23·11 | | −25·24 | | −26·50 | |
| $V_d$ | − ·09 | | − ·28 | | − ·27 | | − ·18 | | − ·22 | | − ·23 | | − ·18 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | +52·0 | | +40·9 | | +49·2 | | +94·3 | | +73·2 | | +58·4 | | +61·1 | |

| λ | 4059 | | 4069 | | 4088 | | 4101 | | 4115 | | 4119 | | 4133 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +70·9 | 1/8 | +104·8 | 1/4 | +105·2 | 1/4 | + 95·9 | 1/8 | +64·9 | 1/8 | +94·2 | 1/8 | +110·6 | 1/2 |
| 4340 | 72·4 | 1/4 | 92·4 | 3/4 | 103·9 | 3/4 | 99·0 | 1/2 | 109·9 | 3/4 | 107·0 | 1/2 | 100·7 | 1 |
| 4101 | +67·5 | 1/8 | + 79·8 | 1/4 | + 96·0 | 1/8 | +113·7 | 1/8 | 100·0 | 1/4 | +93·8 | 1/8 | + 99·2 | 1/8 |
| 3970 | | | | | | | | | +75·9 | 1/8 | | | | |
| Weighted mean | +70·80 | | +92·36 | | +103·31 | | +100·93 | | +100·02 | | +102·67 | | +103·63 | |
| $V_a$ | −27·97 | | −28·14 | | − 28·55 | | − 29·00 | | − 29·11 | | − 29·31 | | − 29·60 | |
| $V_d$ | − ·23 | | − ·23 | | − ·14 | | − ·20 | | − ·19 | | − ·21 | | − ·18 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | +42·3 | | +63·7 | | +74·3 | | + 71·4 | | + 70·4 | | + 72·9 | | + 73·6 | |

MEASURES OF ν GEMINORUM—*Continued*

| λ | 4638 | | 4698 | | 4710 | | 4719 | | 4732 | | 4740 | | 4752 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +34·8 | ¼ | +48·5 | ¼ | +55·2 | ¼ | +56·1 | ¼ | +67·6 | ¼ | +82·1 | ½ | +63·1 | ¼ |
| 4340 | 40·1 | ¾ | 42·3 | ½ | 59·2 | ½ | 53·3 | ¾ | 61·7 | ¾ | 73·0 | ¾ | 82·1 | ½ |
| 4101 | +34·6 | ¼ | +13·5 | ¼ | +76·4 | ⅛ | +36·3 | ¼ | +59·5 | ¼ | 80·0 | ¼ | +65·9 | ¼ |
| 3970 | ..... | | ..... | | ..... | | ..... | | ..... | | +61·9 | ¼ | ..... | |
| Weighted mean | + 37·94 | | + 36·65 | | + 60·51 | | + 50·46 | | + 62·44 | | + 73·83 | | + 74·36 | |
| $V_a$ | + 28·86 | | + 19·69 | | + 12·24 | | + 10·80 | | + 1·15 | | + 1·07 | | − 5·76 | |
| $V_d$ | − ·02 | | − ·14 | | − ·21 | | − ·14 | | − ·11 | | − ·11 | | − ·14 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | + 66·5 | | + 55·9 | | + 72·3 | | + 60·8 | | + 63·4 | | + 74·5 | | + 68·2 | |

| λ | 4763 | | 4782 | | 4794 | | 4803 | | 4813 | | 4821 | | 4836 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +88·3 | ⅛ | +83·3 | ¼ | ..... | | +93·9 | ½ | +109·2 | ⅛ | +23·0 | ¼ | +102·0 | ¼ |
| 4340 | 66·2 | ½ | 78·9 | ¾ | +79·4 | ¾ | 90·0 | 1 | 67·3 | ¾ | 46·1 | ½ | 94·2 | ¾ |
| 4101 | 45·0 | ¼ | +74·2 | ½ | +67·3 | ½ | 80·3 | ¼ | 53·5 | ¼ | +48·8 | ¼ | + 92·1 | ¼ |
| 3970 | +73·3 | ¼ | ..... | | ..... | | +52·7 | ¼ | +56·9 | ⅛ | ..... | | ..... | |
| Weighted mean | +65·52 | | +78·07 | | +74·56 | | +85·10 | | +67·69 | | +41·00 | | +95·34 | |
| $V_a$ | − 7·30 | | − 8·33 | | −10·32 | | −11·79 | | −14·64 | | −15·09 | | −21·99 | |
| $V_d$ | − ·18 | | − ·18 | | − ·11 | | − ·18 | | − ·21 | | − ·18 | | − ·18 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | +57·8 | | +69·3 | | +63·8 | | +72·8 | | +52·6 | | +25·5 | | +72·9 | |

| λ | 4841 | | 4872 | | 4883 | | 4886 | | 4903 | | 4907 | | 4915 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +99·3 | ¼ | + 84·0 | ¼ | +123·0 | ⅛ | +83·0 | ⅛ | +98·3 | ¼ | +115·2 | ¼ | + 70·0 | ¼ |
| 4340 | 80·0 | 1 | 101·3 | 1 | 92·3 | ½ | 85·7 | ½ | 88·5 | ½ | 113·1 | ½ | 98·7 | ½ |
| 4101 | +85·1 | ¼ | + 67·2 | ·¼ | + 78·0 | ⅛ | +93·1 | ⅛ | +97·0 | ¼ | + 95·4 | ⅓ | 109·7 | ¼ |
| 3970 | ..... | | ..... | | ..... | | ..... | | ..... | | ..... | | +101·6 | ⅛ |
| Weighted mean | +84·07 | | + 92·73 | | + 95·03 | | + 86·50 | | + 93·08 | | +106·44 | | + 95·09 | |
| $V_a$ | −22·32 | | − 27·93 | | − 28·98 | | − 29·06 | | − 29·64 | | − 29·72 | | − 29·77 | |
| $V_d$ | − ·11 | | − ·28 | | − ·28 | | − ·23 | | − ·21 | | − ·21 | | − ·21 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | +61·4 | | + 64·2 | | + 65·5 | | + 56·9 | | + 63·0 | | + 76·2 | | + 64·8 | |

MEASURES OF $\nu$ GEMINORUM—*Continued*

| λ | 4924 | | 4933 | | 4940 | | 4965 | | 4976 | | 5285 | | 5311 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +76·2 | ¼ | +82·7 | ½ | +116·0 | ¼ | +81·9 | ¼ | + 77·8 | ¼ | +33·6 | ¼ | +94·3 | ¼ |
| 4340 | 83·8 | ½ | 95·1 | 1 | 106·5 | 1 | 87·9 | ½ | 81·6 | ½ | 71·4 | ½ | 62·6 | ½ |
| 4101 | +79·4 | ¼ | 95·9 | ¼ | 110·4 | ½ | 91·4 | ¼ | +106·8 | ¼ | +47·6 | ¼ | 58·4 | ¼ |
| 3970 | ..... | | +99·4 | ¼ | + 74·9 | ¼ | +81·3 | ¼ | ..... | | ..... | | +50·0 | ¼ |
| Weighted mean | + 81·00 | | + 92·65 | | +104·71 | | + 86·54 | | + 84·95 | | + 56·00 | | + 65·58 | |
| $V_a$ | − 29·72 | | − 29·45 | | − 28·98 | | − 27·19 | | − 26·30 | | + 2·78 | | − 6·71 | |
| $V_d$ | − ·27 | | − ·23 | | − ·18 | | − ·21 | | − ·23 | | − ·25 | | − ·25 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | + 50·7 | | + 62·7 | | + 75·3 | | + 58·8 | | + 58·1 | | + 58·2 | | + 58·3 | |

| λ | 5315 | | 5339 | | 5350 | | 5356 | | 5362 | | 5372 | | 5387 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | ..... | | +55·6 | ¼ | ..... | | ..... | | +82·2 | ¾ | ..... | | ..... | |
| 4340 | +71·9 | ¾ | 80·6 | ½ | +61·2 | ½ | +62·7 | ¾ | 79·9 | ½ | +74·9 | ¾ | +81·2 | 1 |
| 4101 | 79·7 | ½ | 84·0 | ¼ | +68·5 | ¼ | +76·8 | ¼ | +77·3 | ¼ | +81·0 | ½ | +77·5 | ¾ |
| 3970 | +73·5 | ¼ | +77·2 | ¼ | ..... | | ..... | | ..... | | ..... | | ..... | |
| Weighted mean | + 74·80 | | + 75·60 | | + 63·63 | | + 66·22 | | + 79·82 | | + 77·36 | | + 79·66 | |
| $V_a$ | − 8·69 | | − 18·88 | | − 20·03 | | − 21·53 | | − 22·26 | | − 23·89 | | − 25·62 | |
| $V_d$ | − ·18 | | − ·25 | | − ·20 | | − ·17 | | − ·18 | | − ·16 | | − ·14 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | + 65·6 | | + 56·2 | | + 43·1 | | + 44·2 | | + 57·1 | | + 53·1 | | + 53·6 | |

| λ | 5394 | | 5409 | | 5418 | | 5429 | | 5447 | | 5456 | | 5469 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +82·1 | ½ | +76·5 | ¼ | +106·2 | ¼ | +98·2 | ¼ | +81·4 | ¼ | +83·3 | ¼ | +85·1 | ¼ |
| 4340 | 87·0 | ¾ | 95·5 | ½ | 84·9 | ½ | 88·6 | ½ | ,60·0 | ½ | 82·2 | ¾ | 80·5 | ¼ |
| 4101 | +85·4 | ½ | +93·4 | ½ | +78·8 | ¼ | +84·2 | ¼ | +72·6 | ¼ | +89·9 | ¼ | +91·1 | ¼ |
| Weighted mean | + 85·14 | | + 90·86 | | + 88·70 | | + 89·90 | | + 68·50 | | + 83·96 | | + 85·57 | |
| $V_a$ | − 25·89 | | − 26·85 | | − 28·22 | | − 28·81 | | − 29·12 | | − 28·89 | | − 28·16 | |
| $V_d$ | − ·25 | | − ·18 | | − ·25 | | − ·27 | | − ·25 | | − ·25 | | − ·28 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | + 58·7 | | + 63·5 | | + 60·0 | | + 60·5 | | + 38·9 | | + 54·5 | | + 56·8 | |

MEASURES OF ρ GEMINORUM—*Concluded*

| λ | 5496 | | 5851 | | 5866 | | 5895 | | 5923 | | 5940 | | 7482 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +86·1 | ¼ | ..... | | +53·2 | ⅛ | +58·1 | ¼ | +59·9 | ⅛ | +60·4 | ¼ | +12·2 | ½ |
| 4340 | 81·4 | ¾ | +19·3 | ½ | 45·6 | ¼ | 56·7 | ½ | +59·1 | ¼ | 60·6 | ¾ | 17·7 | ½ |
| 4101 | +74·1 | ¼ | +39·6 | ½ | +54·2 | ¼ | +65·5 | ½ | ..... | | +60·0 | ¼ | + 4·6 | ¼ |
| Weighted mean | + 80·88 | | + 29·45 | | + 50·76 | | + 60·50 | | + 59·37 | | + 60·44 | | + 12·08 | |
| $V_a$ | − 26·83 | | + 2·37 | | − 2·33 | | − 12·97 | | − 21·09 | | − 23·16 | | − 8·74 | |
| $V_d$ | − ·23 | | − ·20 | | − ·10 | | − ·14 | | − ·25 | | − ·11 | | + ·09 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | + 53·5 | | + 31·3 | | + 47·8 | | + 47·1 | | + 37·8 | | + 36·9 | | + 3·2 | |

| λ | 8701 | | 8702 | | 8708 | | 8710 | | 8712 | | 8713 | | 8714 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. | Vel. | Wt. |
| 4861 | +76·1 | ¼ | +76·4 | ¼ | +85·2 | ¼ | +63·1 | ½ | +61·9 | ½ | +93·8 | ¼ | +76·7 | ½ |
| 4340 | 41·0 | ¾ | 62·1 | ½ | 48·6 | ¾ | 52·0 | ¾ | 52·4 | ¾ | 33·4 | ½ | 35·7 | ½ |
| 4101 | +56·8 | ¼ | +50·8 | ¼ | +44·4 | ¼ | +45·1 | ¼ | +53·7 | ½ | +56·7 | ¼ | +63·0 | ¼ |
| Weighted mean | + 50·98 | | + 62·85 | | + 55·08 | | + 54·55 | | + 55·50 | | + 54·32 | | + 57·56 | |
| $V_a$ | − 12·81 | | − 14·26 | | − 17·35 | | − 21·32 | | − 22·04 | | − 23·43 | | − 23·43 | |
| $V_d$ | − ·06 | | − ·09 | | − ·02 | | + ·04 | | ·00 | | − ·13 | | − ·21 | |
| Curv. | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | | − ·28 | |
| Radial Velocity | + 37·8 | | + 48·2 | | + 37·4 | | + 33·0 | | + 33·2 | | + 30·5 | | + 33·6 | |

GROUPED VELOCITIES

| Observatory | Epoch | Number of Plates | Velocity | O−C |
|---|---|---|---|---|
| Yerkes | 1903·95 | 2 | +27·5 | −18 |
| " | 1906·16 | 1 | 6· | −12 |
| " | 1908·07 | 1 | 15· | + 3 |
| " | 1909·00 | 1 | 20· | − 6 |
| Ottawa | 1910·97 | 2[2] | 70·0 | + 0·4 |
| " | 1911·95 | 26 | 63·9 | − 3·0 |
| " | 1913·13 | 17 | 55·6 | + 2·7 |
| " | 1914·05 | 5 | 40·1 | 0·0 |
| " | 1916·18 | 6 | 14·9 | 0·0 |
| " | 1919·09 | 7 | +36·0 | 0·0 |

These velocities are plotted on the accompanying graph, in which the curve shown represents the following elements. The curve was obtained graphically with only a few trials and no attempt has been made to improve the elements by a least-squares solution.

PROVISIONAL ELEMENTS

ÉCOLE POLYTECHNIQUE DE MONTRÉAL
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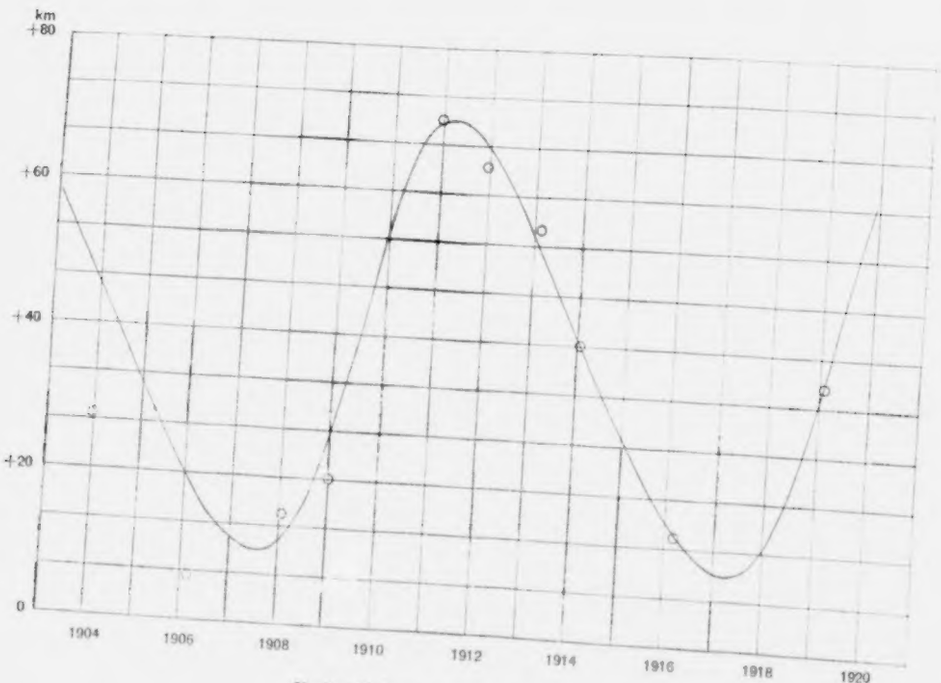
$$
\begin{aligned}
P &= 9{\cdot}6 \text{ years} \\
e &= {\cdot}20 \\
\omega &= 285^\circ \\
\gamma &= +38{\cdot}45 \text{ km.} \\
K &= 30{\cdot}0 \text{ km.} \\
T &= 1909{\cdot}75 \\
a \sin i &= 1{,}417{,}000{,}000 \text{ km.}
\end{aligned}
$$

The general character of the spectrum would seem to bear out this long-period variation. The spectrum of the star which gives the fairly sharp lines whose measures are here recorded, and which may be called component 1, would seem to overlie that of one (component 2) consisting of faint and very broad bands, so broad in fact that they were never separated from the other. When the velocities for component 1 were at their maximum around 1911, the spectral lines were nearly at the extreme red edge of the broad bands corresponding to component 2. The minimum is not so well recorded, but apparently at that time there is more of the band showing to the red than to the violet. At intermediate points the principal lines are more nearly central on the bands. Minor variations, due possibly to the third component of the triple system, whose period is as yet undetermined, complicate matters but the foregoing, while given with a certain amount of reserve, seems to describe the general character of the spectrum. It is hoped to follow the star from time to time to more definitely determine the elements.

Dominion Observatory
Ottawa
February, 1919.




Radial Velocity Curve of $\nu$ Geminorum